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ABSTRACT

The TACCOL project (Technology Advancing A Continuous Community of Learners) at Clarion University of Pennsylvania involves a collaboration between the College of Arts and Sciences and the College of Education and Human Services. The purpose of TACCOL is to infuse technology into teacher preparation by integrating technology with an interdisciplinary approach to teaching science and mathematics. TACCOL involves three distinct populations: (1) university faculty; (2) inservice mathematics and science teachers; and (3) preservice mathematics and science teachers. The basic technologies incorporated into the project are: (1) laptop computers; (2) graphing calculators (TI-73 for elementary participants and TI-89 for secondary participants); (3) Calculator Based Rangers (CBRs); and (4) Calculator Based Laboratories (CBLs) with multiple probes. The constructivist philosophy of engaging learners with hands-on activity based projects is emphasized in the implementation of the workshops for all three populations. (Contains 11 references.) (ASK)

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TACCOL: Technology Advancing A Continuous Community of Learners

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Presented at AMTE, February 10, 2000

The results of the Third International Mathematics and Science Study (TIMSS, 1997, 1998) indicate that a radical change in direction, content, and methods of teaching must occur if United States mathematics students are to be internationally competitive. The ranking of the United States mathematics students in the eighth grade TIMSS study is below the average of other countries. The twelfth grade results are even more disturbing with only two countries in the study ranking lower than the United States. In order to meet the challenge presented by this need for improvement, modifications must be made in the pedagogical practices of American secondary mathematics teachers (U.S. Department of Education, 1998; Carbone, 1998).

The TIMSS study also reveals that mathematics teachers in the United States are emphasizing procedural knowledge, rather than conceptual knowledge, mostly through their daily routines of lecturing and assigning homework. Changes in these pedagogical practices are necessary and should be directed toward teachers becoming facilitators of learning, rather than dispensers of knowledge (Seeley, 1995). The traditional approach to instruction in which students memorize rules and perform algorithms to solve routine problems is in contrast to a new view of mathematics learning that is characterized by thinking, reasoning, and communicating. In the new perspective, teachers lead classroom activities that are activity-oriented and applicable to real world settings. Students are also led to explorations and experimentation prior to introducing formulas (Berliner, Stein, Sabers, Claridge, Cushing, & Pinnegar, 1988; Burrill, 1997; Scheaffer, 1995; TIMSS, 1997; Falk, 1996).

The directives necessary to bring about this change already exist. National organizations have not only called for changes, but have provided suggestions for change. In the area of statistics education, The American Statistical Association's (ASA) Teaching Principles for Quantitative Literacy (ASA, 1991) and the National Council of Teachers of Mathematics (NCTM) [The Curriculum and Evaluation Standards for School Mathematics (1989), The Professional Standards for Teaching Mathematics (1991), and The Assessment Standards for School Mathematics (1995)] provide suggestions for changing mathematics instructional practices. Unfortunately, these

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suggestions have not been implemented sufficiently to have a strong impact on mathematics instruction.

While many practicing teachers may be aware of the suggestions for reform, barriers within the educational milieu, or a lack of content or pedagogical knowledge may be reasons why they do not to implement the national suggestions. Some teachers apparently do not understand sufficiently how to execute the suggested improvements while others do not have the necessary support from their school districts and colleagues to attempt something innovative. One solution to this problem may be well-designed professional development programs (Silver, 1998) that provide teachers with the knowledge and support needed for implementation.

The TACCOL project, Technology Advancing A Continuous Community of Learners, at Clarion University of Pennsylvania involves a collaboration between the College of Arts and Sciences and the College of Education and Human Services. The purpose of TACCOL is to infuse technology into teacher preparation by integrating technology with an interdisciplinary approach to teaching science and mathematics. Funding for the project is through a $455,500.00 grant from the Pennsylvania Department of Education Link-to-Learn Higher Education Initiative "Integrating Technology into Teacher Preparation" and Clarion University. TACCOL involves three distinct populations: (1) university faculty, (2) in-service mathematics and science teachers, and (3) pre-service mathematics and science teachers. The basic technologies incorporated into the project are: (1) laptop computers, (2) graphing calculators (TI-73's for elementary participants and TI-89's for secondary participants), (3) Calculator Based Rangers (CBRs), and (4) Calculator Based Laboratories (CBLs) with multiple probes. The constructivist philosophy of engaging learners with hands-on activity based projects is emphasized in the implementation of the workshops for all three populations.

Technology Competencies

The technology competencies gained as a result of this project include:

using word processing, spreadsheet, and database software and the appropriate hardware as tools for enhancing personal productivity and for teaching mathematics and science content.

increasing content knowledge in mathematics and science

gathering data from the Internet to enhance instruction

creating interactive instructional modules using PowerPoint

using telecommunication systems to receive and send email messages, create listservs, and utilize the Internet as an instructional resource.

integrating Calculator Based Laboratories (CBLs), Calculator Based Rangers (CBRs), probes, TI-89 and TI-73 graphing calculators into mathematics and science instruction.

These competencies support effective teaching of the Pennsylvania Academic Standards for Mathematics and the emerging Pennsylvania Academic Standards for Science and Technology for grades K - 12.

The Reform Pedagogy

All changes have ramifications and the introduction of technology into teacher preparation is no exception. Fortunately, the reform pedagogy that is used to change teaching practices closely follows the ten Teaching Principles of Quantitative Literacy (American Statistical Association, 1991). Faculty from the Department of Education in the College of Education and Human Services collaborated with faculty from the Departments of Physics and Mathematics in the College of Arts and Sciences to develop the workshops. Blending the expertise proves highly effective.

The traditional lecture format is not used during the TACCOL workshops at Clarion University. Instead, activity-based learning opportunities are incorporated into the learning process. During the workshops, students employ the four different types of technology to gather data about questions and issues that are of interest to them. Participants gather real data while conducting their scientific experiments. Their hands-on experiences with the data is observed to provide them a feeling of ownership of the data, and seems to further their interest in the analysis of the data. Although data collection is an underlying theme of the workshop, traditional topics in statistics are deliberately not taught until the participants have first gained experience in working with simple counting and graphing techniques. This delay allows the participants to develop a foundation prior to the introduction of advanced topics such as correlation and presenting data with a mathematical model. I discussed my father's misunderstanding of the theory of probability through his continual fascination of playing the lottery. He obviously does not understand the probability of winning if he continually purchases lottery tickets. My father feels that the odds of his winning are one to two, since he either wins or he does not. When I related it to a cartoon by

Bruce Beattie, of the Daytona Beach News-Journal, where a man selling lotto tickets tells his customer, "They've upped the odds. Your chances of winning are now the same as being struck by lightning during your honeymoon with Cindy Crawford." Now, I believe, my father has an understanding of the probability of winning. Through tossing a hundred coins and determining how many heads there are, the workshop participating teachers should understand the probability of a head is one out of two trials.

Throughout the workshop, emphasis is placed continually on the use of good examples and intuition, rather than on probability paradoxes and the use of statistics that deceive. Each separate group is encouraged to develop a different approach to solve a given problem. Since both graphing calculators and the laptop computers are readily available for their use, participants have a choice when selecting their approach. Next, the groups analyze and evaluate the different methods that they have used with the technology. The emphasis for all activities is for the students to appreciate the analysis and the communication of that analysis, rather than on merely obtaining a single answer.

The in-service teachers are involved in classroom projects during the summer workshop and then again during two follow-up sessions that are held during the fall semester. Each in-service teacher is expected to implement, in their respective classroom, a project that incorporates one of the technologies that they learned at the summer TACCOL experience. Standard concepts, such as measurement, help form interdisciplinary links between mathematics and science for the participants.

The progression of the learning begins with a concrete experience, moves to a pictorial representation involving graphs and charts, and then ends with the formation of an applicable abstract concept. In the previous example, the concrete experience was the tossing of the pennies and the counting of the heads. The pictorial representation was the presentation of the data in a chart, with the trial number as the x-coordinate, and the number of pennies left as the y coordinate. The abstract concept determined was that the number of heads decreased by approximately one half each time. This resulted in a discussion of the mathematical model that the probability of tossing a head is one out of two possibilities.

After all the groups complete each project, they meet for a large group discussion of the results. The different technologies of the calculators, computers, CBRs, and CBLs with the multiple probes are usually found to have been successfully employed throughout all the workshops.

Developing the Community of Learners

The series of workshops begins with instructing the university faculty members. Members of the Departments of Education, Mathematics, and Physics become a team. The university faculty then teaches the in-service teachers during the summer workshops. Additionally, the university faculty teach the integrated mathematics and science concepts to the undergraduate pre-service teachers during their mathematics and science methods classes. Members of the Departments of Biology and Chemistry are also involved with the undergraduate students. As one of the Project

Directors, I personally taught both the teachers during the summer workshop and the undergraduate students in their mathematics methods course. As a supervisor for the secondary mathematics student teachers, I am presently observing and serving as a mentor to the preservice secondary mathematics teachers during their student teaching experiences.

Notably, the undergraduates who recently began their student teaching experiences, are matched with cooperating teachers who have already attended the TACCOL summer workshops. The collaboration of the cooperating teachers with the pre-service teachers completes the cycle of the continuous community of learners. Some of the other university supervisors are also involved in the TACCOL project, so all three populations have the opportunity to continue to collaborate with each other. Hopefully, this cycle will be continued by using the same cooperating teachers again with the new student teachers in subsequent years. The community of learners is growing and will continue to grow with the continued collaboration of the School of Education and the School of Arts and Sciences at Clarion University of Pennsylvania.

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